



# GPS-MAGNAV

... a low cost, light-weight, autonomous navigation system



This comprehensive navigation system provides full, autonomous navigation in a single self-contained unit. Developed by NASA Goddard Space Flight Center, this technology combines a GPS-based system with a reliable and low-cost magnetometer and processes orbit and attitude solutions using a single algorithm. The result is a lower cost, lighter weight, stand-alone navigation system with greater efficiency and lower power requirements.

## Benefits

- Enables autonomous and uninterrupted operation:** Because the GPS-MAGNAV system uses a magnetometer in addition to GPS, it eliminates GPS initialization delays and dropouts as well as requires no ground data or processing.
- Reduces cost:** This system eliminates the need for expensive gyroscopes or star trackers, significantly reducing costs for navigation systems.
- Reduces weight:** Eliminating gyroscopes also reduces the overall system weight.
- May enable nanosatellites:** The reduction in weight, coupled with the system's comprehensive, self-contained operation may also enable further development of micro/nanosatellite systems.
- Reduces power requirements:** Processing orbit and attitude solutions using a single algorithm and with lower weight components results in reduced power consumption.
- Expandable:** Additional ports can also be added to the system to allow input from other types of sensors if necessary (e.g., sun sensors and/or horizon sensors or gyroscopes).

## Applications

- Low Earth Orbit Satellites (e.g., as either a primary or backup navigation system)
- Micro/Nanosatellite systems
- Marine navigation (potential)
- Aircraft navigation (potential)

## The Technology

The patented (#6,670,664) GPS-MAGNAV system was originally developed at NASA Goddard Space Flight Center for low earth orbiting (LOE) satellites.

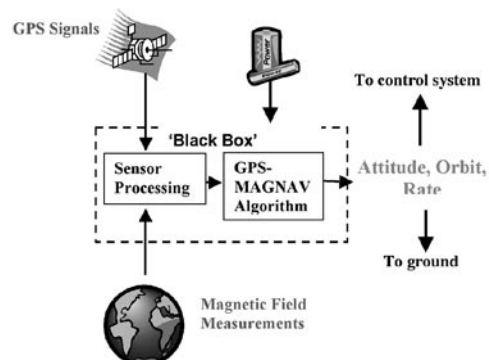
When combined with a gyroscope or star tracker, GPS can provide accurate orbit, attitude, and rate estimates but with an increase in power, mass, and cost. In addition to these drawbacks, GPS can experience initialization delays and signal dropouts that require backup systems in order to fill in data.

Magnetometers can be used to determine orbit and attitude based on the Earth's magnetic field. When a magnetometer is combined with GPS a more robust and accurate navigation system is created that takes advantage of the estimation qualities of both types of measurement.

Based on modeling, the GPS-MAGNAV system is capable of positional solutions accurate to less than 100m, velocity solutions to within 10 cm/sec, attitude solutions to within 0.5 degrees, and angular rates to within 0.0005 deg/sec.

## How It Works

The GPS-MAGNAV technology combines a GPS-based system with a reliable and low-cost magnetometer and processes orbit and attitude



solutions using a single algorithm. This self-contained unit performs autonomous navigation with three primary components: a processor card to host the navigation algorithm, a

magnetometer card, and a GPS card. The algorithm used is an extended Kalman filter (EKF) that is combined with a "pseudo-linear" Kalman filter algorithm.

## Why It Is Better

By utilizing a magnetometer, no ground data is required, enabling the system to operate autonomously. The magnetometer also eliminates the need for heavy and expensive gyroscopes or star trackers, resulting in a lower cost and lighter weight unit. The GPS-MAGNAV system utilizes a single algorithm to process attitude, orbit, and rate simultaneously, requiring less processing power.

The resulting self-contained and fully autonomous navigation system is lightweight, has lower power requirements, and costs less than current navigation systems. Additionally, because of its low weight and cost, this navigation system has the potential to be an enabling technology for micro/nanosatellites.

## Licensing and Partnering Opportunities

This technology is part of NASA's Innovative Partnerships Program, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to consider licensing the GPS-MAGNAV System (GSC-14463-1) for commercial applications.

## For More Information

If you are interested in more information or want to pursue transfer of this technology, please contact:

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More information about working with NASA Goddard's Office of Technology Transfer is available online: <http://techtransfer.gsfc.nasa.gov>